TANKS IN UKRAINE 2022

MARK GALEOTTI

ILLUSTRATED BY FELIPE RODRÍGUEZ

NEW VANGUARD 341

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TANKS IN UKRAINE 2022

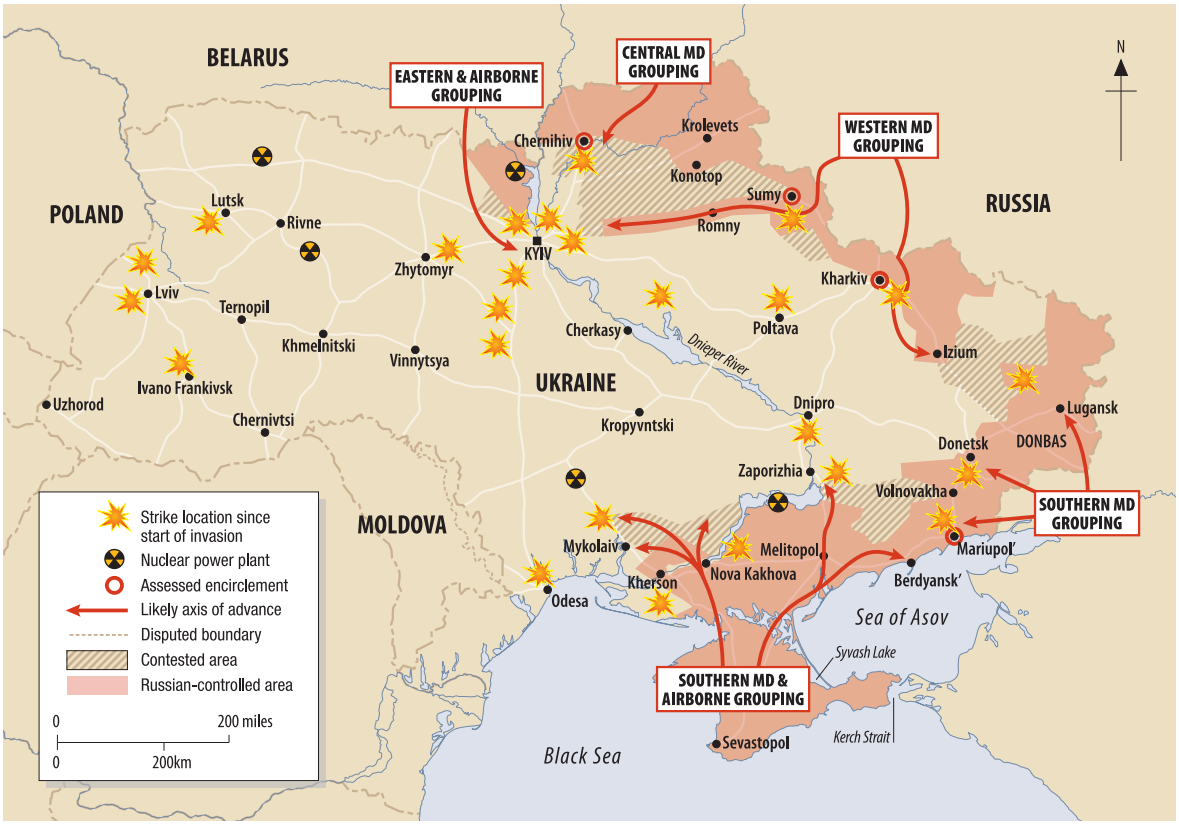
INTRODUCTION

The full-scale invasion of Ukraine in February 2022 saw mechanized war return to Europe. Beyond the Balkan Wars and 2008 invasion of Georgia, European conflicts had been small-scale and 'hybrid' (such as in Crimea[1]) or scarcely-mechanized (including the undeclared war in the Donbas). While armour played a very limited role in various NATO out-of-area operations in the Middle East and Africa, the closest thing to real tank-on-tank actions involving European forces took place in the context of the 1990–91 Iraq War, some 30 years prior.

Although Russian President Vladimir Putin's assertion that 'the true sovereignty of Ukraine is possible only in partnership with Russia… For we are one people' is one which many Ukrainians fiercely contest, the two countries do share a great deal of history and the two nations did spring from the same Soviet state at the end of 1991. As a result, even 30 years on, they still drew on similar military lessons and traditions, and above all, had inventories of weapons and equipment that came from the same sources and the same design philosophies. Both nations had developed in different ways,

1 See Mark Galeotti, RAID *59 Putin Takes Crimea 2014* (Osprey, 2023)

Ukraine's 2013–14 Revolution of Dignity, also known as the Euromaidan, not only toppled a corrupt (albeit elected) leader, it also provoked Vladimir Putin first into annexing Crimea and then an undeclared war, as he was not willing to let Kyiv leave what he regarded as Moscow's rightful sphere of influence. (Sasha Maksymenko, CC Attribution 2.0 Generic Licence)



not least in how they upgraded their tank fleets, but it did mean that in 2022, one descendant of the Soviet tank tradition found itself facing another.

The 2014 Revolution of Dignity, which toppled the Moscow-friendly government of President Viktor Yanukovych, led to a dramatic worsening of Russo-Ukrainian relations. Putin denounced this as a Western-backed, if not outright-organized coup, and shortly thereafter annexed the Crimean Peninsula. Risings and protests in Ukraine's predominantly Russian-speaking south-eastern Donbas region were encouraged by Russian nationalists and elements of the government. This turned into a full-scale rebellion that the Kremlin then chose to back, starting an undeclared war that simmered all the way into 2022 when Putin, apparently losing patience with indirect pressure and convinced that the Ukrainians would not resist the imposition of a puppet government, chose to invade.

The war began with air and missile strikes on the morning of 24 February 2022, followed by attacks all around Ukraine's borders with Russia and Belarus. As well as national will and leadership, it also became a test of quite how each side had chosen to upgrade its tanks and its armoured doctrine and tactics. While Moscow chose not to deploy its much-hyped but apparently still-undeployable T-14 Armata, it threw some of its most modern vehicles into the fray, including the T-90M, which first entered service in 2017 and the 2016 version of the heavily upgraded T-72B3. At first, and especially in its over-ambitious attempt to push forces to Kyiv, it faced largely Ukrainian anti-tank systems, from Javelin and NLAWS missiles supplied respectively by the USA and Britain, to Turkish-made Bayraktar TB2 drones and even

Even more than Russia, Ukraine's armed forces were, until the invasion, dependent on Soviet-legacy weapons, such as these dated BMP-2 IFVs, shown here during an Independence Day parade in Kyiv. (Vitaliy, CC Attribution 3.0 Unported Licence)

improvised roadside bombs. Elsewhere, and especially as the war evolved, coming to focus on the south-east of the country, the defenders' tanks came more to the fore. These included their own distinctive versions of Soviet-era designs, like the T-64BM Bulat and the T-84 Oplot, both products of the post-independence Ukrainian defence industries. The result would be clashes testing not just how the respective sides had built on Soviet-era designs and technologies, but also how they had refined the tactics of armoured warfare they had inherited.

Wars are always forcing houses of innovation and expediency, though, and this one more than most. The Ukrainians in particular proved quick to explore new ways of developing their tank fleet, from battlefield modifications to political outreach to the West for assistance in this specific domain. Although 2022 would not see the introduction of the more advanced Western-built tanks that would arrive later, former Warsaw Pact countries that had become members of NATO were quick to provide their own modernized versions of Soviet designs. These were, after all, easier for the Ukrainians to learn how to crew and maintain and yet also incorporated significantly improved components. Meanwhile the Russians were also beginning to adapt, from the battlefield modifications which would see their vehicles begin to sport additional armour and anti-drone cages, through to tactical innovations which would slowly see them remembering the combined-arms warfare which was meant to have been at the heart of their style of war.

UKRAINIAN TANK FORCES BEFORE THE INVASION

The post-independence Ukrainian army inherited Soviet organizational structures and its tank-heavy way of war, and with it the elements of the Soviet armed forces based on its soil, which left it with an inventory of some 6,500 tanks and 7,000 other armoured vehicles. The 1990s, though, were especially tough for Ukraine, which suffered hyperinflation, a collapse in industrial output, and a consequent steady decline in its Gross Domestic Product (GDP). Military reform was by no means a priority, and although a new State Programme for the Construction and Development of the Armed Forces of Ukraine was adopted at the end of 1996, budgets never met aspirations. The army was substantially shrunk; having inherited a total strength of 800,000 officers and men in 1991, by 1998 it had fallen to 320,000. Divisions were downsized into brigades (many of which were still under-strength): the 28th Guards Motor Rifle Division (Div), for example, became the 28th Mechanized Brigade (Bde), while the 180th Motor Rifle Div was first redesignated the 27th Mechanized Brigade in 1992, and then disbanded altogether in 2004. The defence industrial complex, starved of domestic procurement orders and subsidies, reoriented itself in a desperate quest for export sales. This was reflected in its tank forces, which dwindled at a dramatic rate.

Soviet armies and corps inherited by the Ukrainian Army, 1991	
1st Guards Army	became 1st Army Corps, then Northern Territorial Directorate
6th Guards Tank Army	became 6th Army Corps, then Southern Territorial Directorate
8th Tank Army	became 8th Army Corps, dissolved 2015
13th Army	became 13th Army Corps, dissolved 2015
38th Army	dissolved 2003
32nd Army Corps	became Coastal Defence Forces Command 2003, dissolved 2004

Under Yanukovych, the armed forces declined further; conscription was briefly abolished, and by the end of 2013, Ukraine only had some 121,000 active-duty soldiers. After the 2014 Revolution of Dignity and the annexation of Crimea, though, Kyiv moved quickly to address its military weaknesses. Conscription was revived, rates of pay revised upwards and, by the end of that year, the combat strength had risen to 204,000. This would reach almost 300,000 by 2022 including the Territorial Defence Forces and National Guard, with defence spending at around 5 per cent of GDP (compared with, for example, the 2 per cent of GDP which had been the NATO target figure for its members – and which was often not even reached). Meanwhile, a deliberate 'de-Sovietization' policy was adopted, with Western-style ranks and uniforms introduced, and the term 'comrade' abandoned as a greeting.

The Armoured Troops (TV) was an arm of the Ground Forces, which had experienced particularly significant neglect. By 2014, it had only two remaining brigade-strength formations: the 17th (which had been the 17th Tank Div of the 6th Guards Tank Army) and the 1st (which had been formed in 1997). These were all that remained of the 14 tank divisions which Ukraine had inherited at the end of 1991. However, the new hostility from Moscow led to the formation of three more tank brigades and one independent tank battalion.

With Russia and Ukraine fielding tanks with such similar profiles, both sides took to marking them with recognition symbols that were often later supplemented by national flags, slogans and other embellishments. This Ukrainian T-80U sports not only the cross they used for this purpose but, for good measure, a number of blue-and-yellow Ukrainian flags. (SAMEER AL-DOUMY/AFP via Getty Images)

A Ukrainian tank takes up a firing position in the centre of the contested city of Bakhmut in December 2022. (Andre Luis Alves/Anadolu Agency via Getty Images)

Ukrainian tank units, 2022
1st 'Severian' Tank Bde, Honcharivske, Chernihiv Region (est. 1997)
3rd 'Iron' Tank Bde, Yarmolinski, Khmelnitski Region (est. 2016)
4th 'Hetman Ivan Vyhovski' Tank Bde, Honcharivske, Chernihiv Region (est. 2017)
5th Tank Bde, Kryvyi Rih, Dnipropetrovsk Region (est. 2016)
17th 'Kostiantyn Pestushko' Tank Bde, Kryvyi Rih, Dnipropetrovsk Region (formerly 17th Tank Div)
12th Independent Tank Bn, Honcharivske, Chernihiv Region

Each tank brigade has some 120 tanks, as well as infantry and other support elements (see box below). By 2022, most were equipped with the modernized T-64BM and T-64BV models, of which the Russian Army had some 720 in service (with another 570 in storage). Ukraine also fielded more than 200 T-80UDs and at least 40 T-84s. There were also some older 200 T-72s of one variant or the other, although many were no longer operational or were being used as targets and training vehicles or retained to be converted to other uses.

Production and inventory

Ukraine was one of the main producers of tanks in the USSR: the Kharkiv Morozov Machine-Building Construction Bureau (KhMDB) had actually designed the iconic T-34 that was such a mainstay of the Soviet army in World War II and later would build T-55s, T-64s and also design the T-80UD,

UKRAINIAN TANK BRIGADE

HQ Company (Coy)

3 x Tank Bn, each with 3 x Tank Coy of 3 x 4-tank platoons plus a command tank, for a total of 40 tanks

Mechanized Infantry Battalion (Bn)

Artillery Regiment (Rgt), with SPG Bn, Rocket Artillery Bn, Anti-Tank Bn, Anti-Air (AA) Bn

Recon Coy

Sniper Coy

Engineer Bn

Maintenance Bn

Logistics Bn

Signals Coy

Electronic Warfare Coy

Radar Coy

Medical Coy

Of all the various recognition symbols used by the Russians, the V and, especially, Z have become widely used as markers of Russian patriotism. Here, frames representing both letters have been set up in front of the Kerch Bridge linking Crimea to the Russian mainland. (AFP via Getty Images)

a diesel-engine version of the gas turbine-powered T-80. Despite the serious economic pressures that followed Ukrainian independence at the end of 1991, it survived and went on to develop a series of local variants of Soviet designs, both for the domestic and export markets.

T-64BM Bulat/T-64BV

The single most common tank design in the Ukrainian inventory at the time of invasion was the T-64 in its various iterations. The original T-64, which ended up being deployed within tank divisions while the less capable T-62 served in mechanized 'motor rifle' units, was a ground-breaking tank for the Soviets, with composite armour and a smoothbore 125mm 2A21 gun. The 2A21, at the time the most powerful tank gun in the world, was served by an autoloader, that allowed the crew to be reduced from four to three, and the vehicle's profile kept low, to increase survivability and keep the weight down to 38 tonnes.[2] The downside was that it was expensive – which is why it did not supplant the T-62 – and temperamental, such that many of these innovations needed to be refined in later iterations. Its 5TD engine was unreliable, for example, and the autoloader was notorious for trying to insert the gunner into the breech instead of a fresh round. As a result, it was soon succeeded by the T-64A, with a more powerful 125mm 2A46 main gun, and then the T-64B with an improved fire-control system and the 2A46M1 main gun, which could also fire the 9K112-1 Kobra (NATO code AT-8 Songster) anti-tank missile. Nonetheless, the design was still regarded as sufficiently secret and temperamental that it was not exported, even to fellow Warsaw Pact states.

In the newly independent Ukraine, this tradition of incremental redesign continued, with the KhMDB, the Malyshev Factory (ZIM), also based in Kharkiv, and the Kharkiv Tank-Building Factory (KhBTZ) developing a variety of upgrades, both for domestic use and also in the hope of securing exports. Given that even by 1995, Ukraine had more than 2,300 T-64s – far more than it needed or could afford to field – then modernization of old stock rather than construction of new seemed the most logical and cost-effective option.

2 See Steven Zaloga, NVG 223 *T-64 Battle Tank* (Osprey, 2015)

Main Ukrainian MBTs				
Tank	**Introduced**	**Armament**	**Top Speed**	**Range**
T-64BM Bulat	2010	125mm KBA3 smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT MG	43mph on road 22mph off-road	240 miles (road)
T-64BV	2019	125mm KBA3 smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT MG	40mph on road 22mph off-road	310 miles (road)
T-80UD	1987	125mm 2A46M1 smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT/DShK MG	43mph (50mph for T-80U) on road 30mph cross-country	310 miles (road)
T-84 Oplot	1994	125mm KBA3 smoothbore 7.62mm KT-7.62/PKT coaxial MG 12.7mm KT-12.7/NSVT MG	43mph on road 28mph cross-country	310 miles (road)

By 2010, ZIM was beginning to deliver modernized T-64B tanks to the Ukrainian armed forces in the new T-64BM Bulat variant that was increasingly fitted with domestic systems, as the old Soviet-era defence industrial complex had drawn components from across the USSR. The T-64BM Bulat incorporated the more advanced Nizh (Knife) explosive reactive armour (ERA) as well as the Varta (Sentinel) active protection system, and an automatic fire-suppression system. Its 125mm KBA3 main gun is a locally produced version of the 2A46, and as well as the usual range of rounds can fire the Kombat tandem-warhead laser-guided missile. Although it weighs 45 tonnes, its 850hp 5TDFM multi-fuel diesel engine gives it a top speed of 43mph, with a maximum range of 240 miles, although it proved to be less manoeuvrable than earlier, lighter versions.

The first batch of ten was delivered in 2010, and by 2022, the Ukrainians fielded around a hundred. This was, after all, much cheaper than re-equipping fully with the later version, the T-84. A 2019 upgrade programme led to the T-64BM2 Bulat variant, with an improved fire-control package and TPN-1TPV thermal sight, a more powerful 6TD-1 engine, Lybid-2 radios and the Basalt battlefield information system, and enhancements to the tank's protection including anti-RPG screens over the enlarged engine compartment. The design was undergoing field tests in 2021, but only up to a dozen were definitely in service by the time of the invasion.

A separate programme led to the T-64BV, a modernization programme for the older T-64s led by the KhBTZ. The initial 2017 version lacked the more powerful engine of the T-64BM but did have a range of improvements

A

T-64BM AND T-84 OPLOT

Various models of the T-64 and its successors formed the backbone of the Ukrainian tank fleet in 2022. The top illustration is a T-64BM of the 1st 'Severia' Tank Brigade's 2nd Battalion, marked with the white crosses that were adopted by the Ukrainians in the early stages of the war to distinguish their vehicles from the often-identical Russian ones. In 2022, the brigade took part in the successful defence of Chernihiv and was then redeployed to the Donbas offensive, earning it the 'For Courage and Bravery' unit award. Below is a T-84 Oplot from the 3rd Tank Brigade's 11th Independent Tank Battalion during the Kharkiv counteroffensive in a distinctive blocky digital camouflage pattern. Note the new Duplet ERA blocks, optimized to resist tandem warheads and

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ЗА УКРАЇНУ

A close-up of the infrared (IR) beacon element of the Varta soft-kill active protection system on the turret of a T-84 Oplot, designed to blind IR sensors and missile guidance. (VoidWanderer, CC Attribution-Share Alike 4.0 International Licence)

to its protection systems and sights, with thermal imaging as standard for all crew. In 2019, the Lviv Tank-Building Factory (LBTZ) also began to upgrade existing T-64s to this pattern, and in 2022 a new T-64BV obr.22 version was reported to be going through field tests, with further refinements including the substitution of the commander's turret-mounted machine gun with a domestically produced 12.7mm Snipex Laska K-2. However, it is unclear whether any were actually fielded in the first year of the war.

T-80UD

The T-64 was also the progenitor of the T-80, an evolution of the design built around a powerful (but monstrously fuel-hungry) gas turbine rather than diesel engine, and also incorporating features from the separate and slightly more modern T-72. It was a controversial design, and although the T-80 entered service in 1976, and became the armoured backbone of the Group of Soviet Forces in Germany, it would continue to polarize opinion among users and planners. The Ukrainian Morozov Design Bureau was a partner in developing the second-generation T-80U version, with a more powerful and reliable GTD-1250 gas turbine engine and Kontakt-5 reactive armour, but at the same time was developing an alternative, the T-80UD. This replaced the gas turbine with a more conventional and fuel-efficient diesel. Some 500 T-80UDs had been built by the collapse of the USSR, with 300 still at KhMBD's factory at time of independence (largely being kept in the hope of securing export deals), so the new Ukrainian military eagerly adopted it. Indeed, it was also then able to sell T-80UDs to Pakistan – and 4 T-80Us to the United Kingdom for OPFOR ('opposing force') evaluation purposes, via a middleman ostensibly procuring them for Morocco, with one then supplied to the United States for testing at their Aberdeen Proving Ground.

A T-64BM2 Bulat during rehearsals for the 2021 Independence Day military parade in Kyiv. (VoidWanderer, CC Attribution-Share Alike 4.0 International Licence)

Beyond the adoption of a 1,000hp 6TD multi-fuel turbo-diesel engine, giving it a road range of 310 miles (compared with just over 200 miles for the T-80U), the T-80UD is essentially similar, with the same 2A46M1 smoothbore gun able also to fire the 9M119 Refleks (AT-11) missile. Like the Russian T-80U, in battle the T-80UD proved especially prone to catastrophic 'pop top' damage, in which a penetrating hit detonated stored ammunition and blew the turret off the tank.

The T-80U's powerful gas turbine engine meant that it would be hyped as the 'flying tank' at arms fairs and exhibitions and invariably, at some point, dramatically leap from a suitable ramp to underline its speed. Much less attention was drawn to its fuel consumption. (Photo by Laski Diffusion/Getty Images)

T-84 Oplot

A further refinement of the T-80UD was the T-84, which was developed by the KhMBD in post-Soviet times and first built in 1994. Given the lack of available resources in the tough early years of independence, this was mainly envisaged as an export model, but without much success. Instead, the T-84 began to enter Ukrainian service in 1999, but it was soon superseded by the more advanced T-84 Oplot (Bulwark), with the first ten entering Ukrainian service in 2001. It includes a series of refinements, including an armoured ammunition magazine in its turret bustle, to try and address a familiar problem with Soviet-heritage tanks, of the turret being blown off by a catastrophic explosion when the shells lined up for the autoloader are detonated by an attack. The T-84BM Oplot-M is the current standard, introduced in 2013.

The T-84 Oplot is armed with a KBA3 125mm smoothbore gun, essentially a domestically produced equivalent 2A46M1, stabilized in two planes, with a modern fire-control system including a PTT-2 thermal imaging sight. It

A T-84U of 3rd 'Iron' Independent Tank Brigade, which was issued with T-72s when it was formed in 2016. As of the invasion, it was still in the process of being re-equipped, and so all three of its tank battalions fielded a mix of T-72s and T-84Us. (3rd 'Iron' Tank Brigade/Ukrainian Ministry of Defence, CC Attribution 4.0 International Licence)

THE UNDEPLOYABLE ARMATA

The T-14 Armata, which appeared in 2015, is post-Soviet Russia's first genuinely new tank design, and was presented as a game-changing system, with a remote-controlled turret mounting a 2A821M 125mm smoothbore gun, three crew sitting in a heavily armoured pod inside the main hull, advanced optics and the Afganit active protection system with both soft- and hard-kill capabilities (such that an incoming round not able to be spoofed or distracted would instead be intercepted). The programme was beset with unexplained delays, though, likely because of problems building and integrating its advanced computerized systems, as well as an embarrassing breakdown during the rehearsals for the 2015 Victory Day parade in Moscow. Claims that it had seen service trials in Syria were never confirmed, nor ones that there had been a limited deployment in Ukraine. As it was, on March 2024, it was finally admitted that the T-14 had never been deployed anywhere, and was too expensive either for the war or yet for series production. The T-90 and T-72B3 would thus remain the standard tanks, with only a few dozen T-14s built to date.

also mounts a coaxial 7.62mm KT-7.62 or PKT machine gun, and a remote-controlled 12.7mm KT-12.7 or NSVT machine gun on the commander's cupola. Its armour is supplemented by Duplet ERA, optimized for tandem warheads, and its 2TD-2E multi-fuel engine gives it reasonable mobility, although as of the invasion, the Ukrainians were considering replacing it with a more powerful 6TD-3 following their experience in developing the T-84-120 Yatagan in an ultimately unsuccessful bid to win a Turkish contract.

RUSSIAN TANK FORCES BEFORE THE INVASION

Starting from the same Soviet foundations as the Ukrainians, the Russians had continued to follow their own evolutionary design process (until the T-14, which has still not become operational: see box). Although later, as losses ate into their forces, they would start to have to deploy older systems, the bulk of their tank fleet in 2022 therefore comprised upgraded T-72s, T-80s and T-90s, in a range of variants. While their armoured forces had, like the Ukrainians', decayed seriously in the cash-strapped 1990s, since Vladimir Putin's election to the presidency in 2000, increasing sums had been spent on military reform. The Kremlin's obsession with 'teeth' over 'tail' – in other words, front-line combat assets over logistics, training and similar essential support capabilities – had in particular ensured that the Russian military had modernized its main armoured units.

Most units that were deployed were Battalion Tactical Groups (BTGs), an innovation introduced after 2012 as Russia tried to modernize its army and optimize them for limited overseas interventions. With the brigade having replaced the division as the basic building block of the army as part of the so-called 'New Look' modernization programme launched in 2007, the idea was that each brigade would be able to generate one or two of these

B

UKRAINIAN T-72 AND RUSSIAN T-72BM3

The T-72 was one of the staples of the Soviet tank fleet and remains in service on both sides of the war. Ukraine had largely upgraded its T-72/72As to the new AMT standard, with ERA and other improvements, but the immediate demands of the invasion forced them also to take unmodernized tanks out of storage, especially for the Territorial Defence Forces. The top picture is of a Ukrainian T-72 assigned to one of the few tank platoons in the 114th Independent Territorial Brigade, part of the Kyiv Region security forces. Below is a substantially more-advanced Russian T-72B3 from a BTG generated by the 27th Independent Guards Sevastopol Red Banner Motor Rifle Brigade, part of the Western Military District forces based near Moscow. Note the NSVT heavy machine gun on the turret and the additional slat armour to the rear and Kontakt-5 ERA on the turret and glacis.

СЛАВА УКРАЇНІ!
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Z
СЕВАСТОПОЛЬСКАЯ

The presence of a T-14 Armata following a T-90 is proof that this picture was taken at a stage-managed display – in this case, at the Russian army's Alabino training ground – because this 'wonder tank' has yet to be deployed in a combat role. (Russian Ministry of Defence, CC 4.0)

combined-arms manoeuvre units from its *kontraktniki*, professional soldiers (as conscripts were banned from foreign deployments except in time of war). Their precise composition would vary by mission and parent unit, but a BTG would typically comprise 600–800 soldiers in three mechanized companies and a tank company, with a disproportionate share of the brigade support elements, including a self-propelled howitzer/rocket battalion, an anti-tank company, an air defence platoon, and a squad of engineers. A tank brigade, conversely, might generate a BTG with two companies each of armour and mechanized infantry.

In practice, many of the 110 BTGs deployed in the initial invasion were at least a quarter under-strength, not least given the lack of proper preparation. Moscow's apparently sincere belief that it would win an easy and largely uncontested victory meant, in particular, that it had not mobilized its

Soviet-legacy tanks tend to show little concern for the convenience of their crews, and loading new rounds for the main gun, as being carried out here by DNR servicemen in the Donbas Region's Yasinovatsky district, can be an irksome and time-consuming manual process. (Photo by Leon Klein/ Anadolu Agency via Getty Images)

reserves. Given the legal constraints on sending conscripts abroad (as well as the practical and political risks in doing so), they were having to rely on *kontraktniki* in the ranks of units already deployed along the Ukrainian border. As a result, there were units where infantry fighting vehicles (IFVs) were being driven into battle empty of the soldiers they were meant to be carrying, and tanks deployed, in an unforgivable breach of doctrine and common sense, without the infantry support they need to flush out ambushes and maintain proper situational awareness. In practice, a BTG is a unit best suited to small-scale intervention and counter-insurgency operations, not full-scale war, and it is telling that as divisions began to be recreated, the larger regiment looks set again to be the primary manoeuvre unit.

Russian tank fleet at February 2022	
T-72B	1,135
T-72BA	93
T-72B3/B3M	806
T-80U	186
T-80BV/BVM	279
T-90A	186
T-90M	47

Main Russian MBTs

Tank	Introduced	Armament	Top Speed	Range
T-72	1973	125mm 2A46M smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT/DShK MG	32mph on road 22mph off-road	290 miles (road)
T-72B3	2011	125mm 2A46M-5 smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT/DShK MG	40mph on road 25mph off-road	310 miles (road)
T-80U	1985	125mm 2A46M smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT/DShK MG	50mph on road 30mph cross-country	208 miles (road)
T-90A	2004	125mm 2A46M smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT/DShK MG	45mph on road 37mph cross-country	340 miles (road)
T-90M	2017	125mm 2A46M-5 smoothbore 7.62mm PKT coaxial MG 12.7mm NSVT/DShK MG	45mph on road 37mph cross-country	340 miles (road)

T-72

The T-72 Ural was in many ways the iconic main battle tank (MBT) of the later Soviet military: light, relatively fast and manoeuvrable, low in profile, packing a powerful but not always terribly accurate punch from its 125mm gun, and cheap by the standards of the tanks of the day.[3] Ironically, though, it emerged from a rivalry between design bureaus in which it won out by being the most conventional. KhMBD and Uralvagonzavod from Nizhny Tagil were competing for a replacement for the unsatisfactory T-62. Alexander (Olexander) Morozov from Kharkiv proposed the more ambitious

3 See Steven Zaloga, NVG 6 *T-72 Main Battle Tank* (Osprey, 1993)

This Russian T-72B's Kontakt-5 ERA didn't protect it, and it was abandoned near the village of Bogorodychne in the Donetsk region during back-and-forth struggles for its control through summer and autumn 2022. (SAMEER AL-DOUMY/AFP via Getty Images)

design, with an autoloader, advanced diesel engine and all-new suspension, while Uralvagonzavod's Leonid Kartsev stuck with the turret from the T-62, retaining a fourth crewman as loader. Ultimately, the former design was adopted as the T-64 but while Kartsev's approach initially found favour for its cheapness, it ultimately underperformed in trials. As construction of the more advanced T-64 fell behind schedule, largely because of the complexity of the engine, Kartsev proposed a new design, which incorporated the autoloader and other elements of Morozov's, and this was eventually adopted as a simpler alternative 'mobilization tank' which could quickly be produced in time of war. Eventually, as T-64 production continued to lag, a more advanced iteration of Kartsev's tank was adopted as the T-72, coming into service in 1974.

What became clear is that while the T-72 had its undoubted flaws, including cramped conditions and poor survivability when hit, it would prove an unexpectedly good platform for modernization and also for variants ranging from the BREM-1 armoured recovery vehicle (ARV) to the TOS-1 thermobaric rocket launcher. It would be exported around the world, from Algeria to Yugoslavia. By the time of the invasion, the majority of T-72s in service had been brought to the T-72B3 or T-72B3M standard, introduced in 2011 and 2016, respectively. The T-72B3, drawing on components built for the newer T-90, mounts a 125mm 2A46M5 smoothbore gun also able to fire 9K119M Refleks-M (AT-11) guided missiles, as well as a 7.62mm PKT coaxial machine gun and a 12.7mm NSVT or DShK machine gun on the commander's cupola. A fire-control system built around the PNM Sosna-U panoramic multi-spectral sensor including a French-designed Thales Catherine-FC thermal imager provides better range, accuracy and general situational awareness, although as a result of sanctions, since around 2016 this has been superseded by the domestically built TPK-K. An improved V-92S2F 1,130hp engine and improved suspension offer it superior mobility, while protection has been improved by fitting Relikt reactive armour and side skirts.

A T-72B3 on parade. In many ways, this tank has been the mainstay of Russia's armoured forces in Ukraine, even if technically superseded by designs such as the T-90. (Vitaly V. Kuzmin, Creative Commons Attribution-Share Alike 4.0 International Licence)

T-80

As discussed above, the T-80 was innovative for its use of a gas turbine engine, and controversial for the same reason.[4] Beyond its powerpack, the initial T-80 was beginning to look dated even when fielded. It was under-armoured and not fitted for additional ERA, it could not fire anti-tank guided missiles (ATGMs) through its gun because it lacked the appropriate guidance system, and its fire control was essentially that of the T-64A, whose turret it adopted. As a result, work began immediately on the T-80B model, which was adopted in 1978. This would soon acquire an improved engine but the main advantage was that a new turret meant that it was equipped not only with a more modern fire-control system but also the capacity to fire 9M112 Kobra (AT-8 Songster) missiles. The T-80B also gained better composite armour, intended to help resist the anti-tank missiles of the day.

In 1985, two new versions were introduced. The T-80BV was a quick fix: essentially a T-80B now fitted for Kontakt-1 ERA and armed with an improved 2A46M1 main gun. The T-80U was a more comprehensive revision, with a better engine, new turret fitted for Kontakt-5 reactive armour, more advanced armour on the hull, and the guidance system for the 9K120 Svir laser-guided missile. While the T-80U and the T-80BV were meant to become the standard Soviet MBT, there was still considerable reluctance to commit to the design. In the 1990s, amidst post-Soviet austerity, the Russian defence ministry had decided to standardize either on the T-80 or Uralvagonzavod's T-90. The First Chechen War (1994–96) was an especially bad war for the T-80BV, though, which suffered heavy losses, and although this was not so much because of the design but that they found themselves in urban combat without infantry support against smart, experienced guerrillas – T-72s in similar circumstances performed no better – it severely tarnished the brand. Besides, the thirstiness of the engine was a serious problem. It burns nearly as much fuel while idling as on the move, for example, such that many of the T-80BVs waiting outside Grozny on New Year's Eve 1994 actually ran out of fuel before they could even be ordered into the attack.

4 See Steven Zaloga, NVG 152 *T-80 Standard Tank* (Osprey, 2009)

The turret of a T-80BV fitted with older Kontakt-1 ERA blocks. Note the gunner's thermal imaging sight; the T-80BV was armed with a newer 2A46M1 120mm smoothbore gun able to fire the improved 9M112M Kobra missile, but crews highlighted the importance of the tank's optics over the characteristics of its gun. (Vitaly V. Kuzmin, Creative Commons Attribution-Share Alike 4.0 International Licence)

In 1996, production began to be phased out, although as late as 2001 the Omsk Transmash works were still producing them for export (with sales to Cyprus, Egypt, South Korea, Uzbekistan and Yemen). Nonetheless, in 2017, the T-80BVM upgrade was introduced to make the tank compatible with the T-90 and, by 2022, the Russians still had over 400 T-80s in various models in service, mainly T-80BV/BVMs. They also had perhaps another 5,000 tanks in storage, which they began to recondition to replace battlefield losses. Despite its limitations – some logistics officers have dubbed the T-80 the *obzhora*, 'guzzler', for its fuel requirements – it remains an effective threat on the battlefield, although the experiences of the 4th Guards Tank Div, detailed below, have only strengthened the hand of those who say this was not a successful experiment. A greater proportion of T-80s, after all, were abandoned in 2022 than any other Russian tank line; of all of them lost in the first year, more than two-thirds were captured or abandoned, likely because of their inordinate fuel requirements and the greater chance that they simply ran dry.

T-90

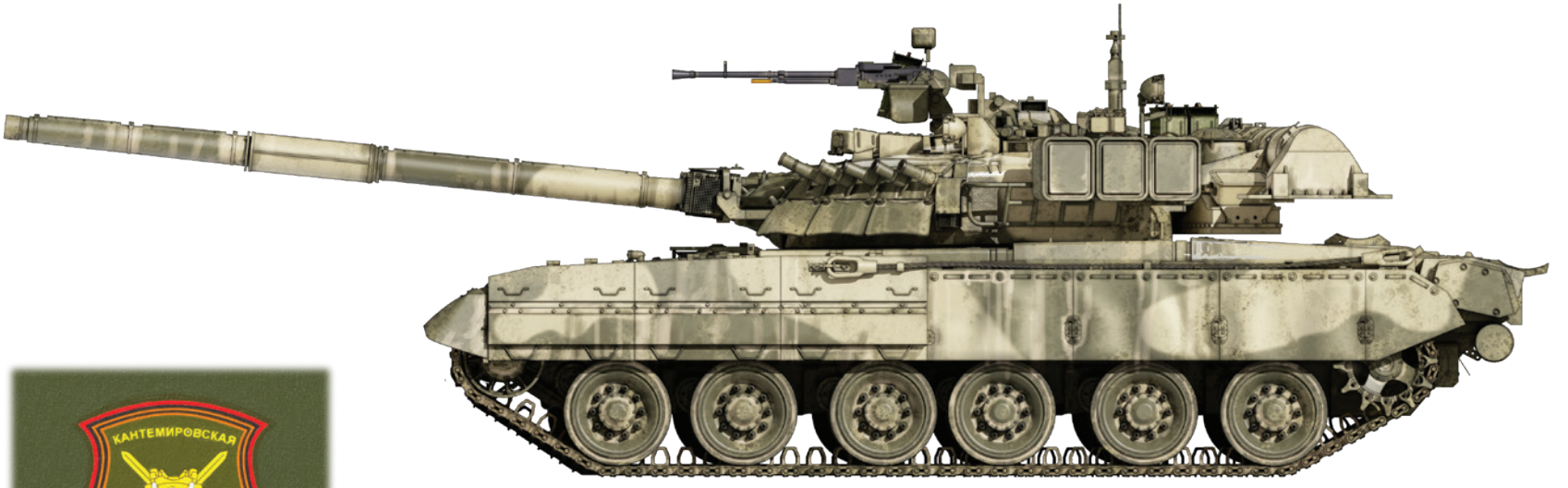
While the T-72 was going through a series of upgrades, the design was also eventually selected as the basis for a new tank which could, in due course, replace the array of different vehicles in use: the T-64, T-72 and T-80 (and some remaining T-62s, for that matter).[5] Once again, a more ambitious

5 See Steven Zaloga, NVG 255 *T-90 Standard Tank* (Osprey, 2019)

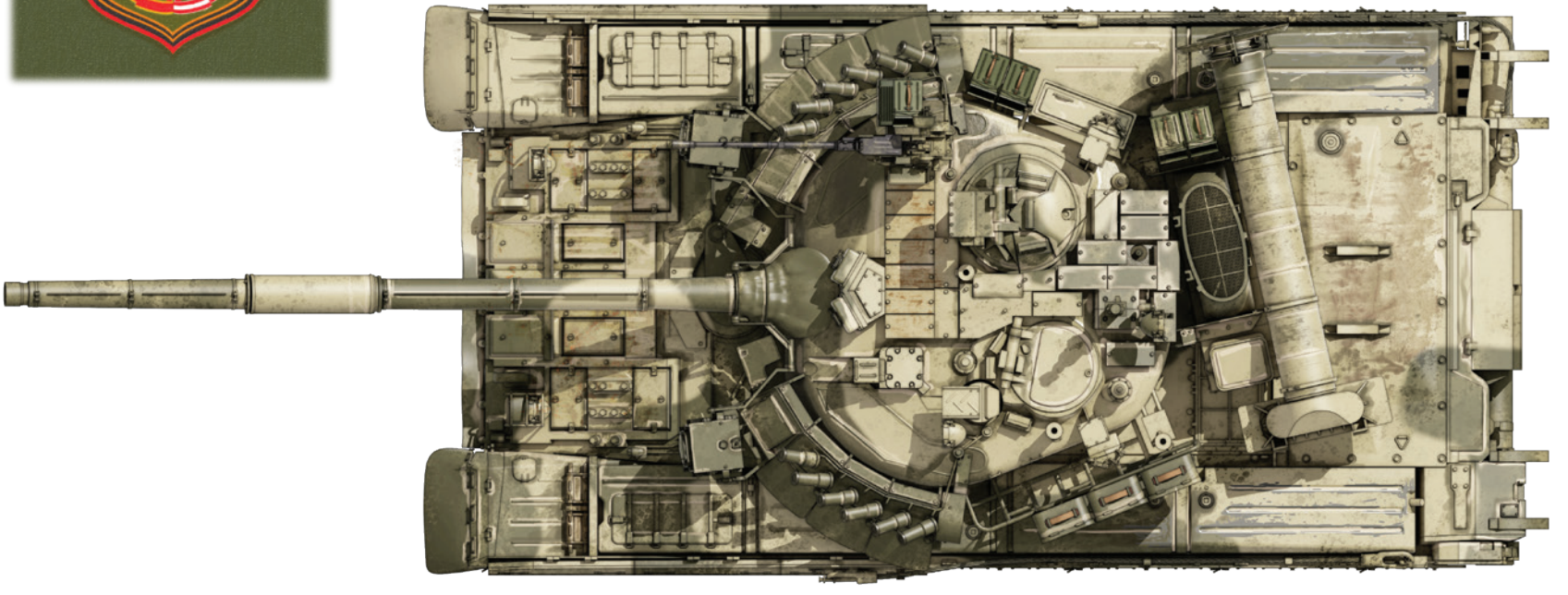
C

T-80UK OF THE 4TH DIVISION

Were it not that Russia so desperately needed tanks to make up for the losses it was suffering, the mauling the 4th Guards Kantemir Tank Division's T-80s received in 2022, especially during their retreat from the Ukrainians' Kharkov counteroffensive, would likely have guaranteed the final withdrawal of the T-80 into mobilization storage. As is, attrition will likely ensure the Russian army soon has few of their old T-80/T-80U stocks left. This is a T-80UK command tank version of the basic T-80U, with improved communications gear and an auxiliary generator to power it when the tank is stationary. Although the decision was made not to make it standard for the T-80 for reasons of cost, the T-80UK mounts the Shtora-1 countermeasures suite also fitted on the T-90 tank,



КАНТЕМИРОВСКАЯ



Two Russian T-80BVs in rough going. (KIRILL KUDRYAVTSEV/ AFP via Getty Images)

design (known as Object 187) was discarded, and a further incremental modernization of the T-72 from Uralvagonzavod was chosen, although eventually the designation T-90 was chosen to mark that this was the first tank to be mass produced in the post-Soviet 1990s, entering service in 1992. It shows its characteristic lineage, but has also been modified in a range of distinctive ways. Its 125mm 2A46M smoothbore gun is better able to fire accurately on the move thanks to a 1A45T fire-control system, with thermal sight, with an effective range of out to over 2 miles, depending on the round, or 3.7 miles with a laser beam-riding Refleks missile with tandem warhead. As well as composite and Kontakt-5 ERA, it mounts the Shtora-1 (Curtain-1) missile-jamming system that activates both smoke grenades and infrared-dazzling beacons when painted by a guidance laser.

An export version, the T-90S, with a more powerful engine was later adopted by the Russians as the T-90A, but the main update was the T-90M *Proryv* (Breakthrough), fielded in 2017. This has a much-improved all-welded turret mounting a more advanced 2A46M5 main gun and improved optics, an even more powerful 1,130hp V-92S2F engine, and a protective suite which replaced the jammers of the Shtora-1 with the Arena-M hard-kill system, as well as Relikt ERA. Considering that catastrophic ammunition explosions have tended to be a vulnerability of these Soviet and Russian designs, which achieve their low profile through tight packing of shells, the T-90 stores most of them to the rear of the turret, where they are considered less likely to be hit, with blowout panels meant to divert any blast away from the crew. The experience of the T-90 in Ukraine has demonstrated that this is only partly effective, but overall, it has proved much more survivable than its

This view of the front hull and turret of a T-90A, sometimes known as the 'Vladimir' after its chief designer, Vladimir Potkin, clearly shows the two active IR emitters of the Shtora-1 protection system on each side of the gun. In use, these can glow, giving the tank distinctive 'red eyes'. (Boevaya mashina, Creative Commons Attribution-Share Alike 4.0 International Licence)

For all its modernization efforts, arguably Russia's personnel carrier fleet remained largely Soviet vintage, such as this BMP-2 IFV, marked with the usual recognition symbols, which was committed to the attack on Balakliya in the Kharkiv Region. (Metin Aktas/ Anadolu Agency via Getty Images)

predecessors. Notoriously, in 1990 a T-90A was accidentally hit by a Konkurs ATGM during the Kavkaz-2020 exercises in the Astrakhan region; the tank was heavily damaged, but with the exception of burns to the commander's face and hands, the crew suffered no serious injuries.

ARMOURED CLASHES, 2022

The first year of the invasion saw relatively few large-scale tank-on-tank engagements, but their central role in Russian tactics ensured they would be in action across the entire battlespace. Three engagements are worth highlighting to demonstrate some of the particular characteristics of this war and the way both sides used their tanks. In the so-called 'Kyiv Convoy' (February/March 2022), what should have been a formidable armoured thrust against Ukraine's capital degenerated into bloody farce, proof that poor planning and co-ordination can outweigh any combat strength. At the battle of Volnovakha (March 2022), the Russians were able to win the day eventually thanks not only to greater numbers but also their capacity to combine their tank forces with infantry and artillery support, in a manner that they so often failed to do in this war. Finally, the decimation of Russia's 4th Guards Tank Div during Ukraine's Kharkiv Offensive (September 2022) was a reminder that the real killer on the battlefield remains the artillery, and if tank forces allow themselves to bunch together along predictable routes, especially in the age of the ubiquitous reconnaissance drone, they suffer as much as anyone else.

The 'Kyiv Convoy' (February/March)

The initial Russian plan had pivoted around a quick seizure of Kyiv through the capture of the nearby Antonov Airfield at Hostomel by helicopter-lifted paratroopers, and using this quickly to airlift in adequate heavier forces. Not only did resistance at the airfield prove more fierce than Moscow had envisaged, but the people of Kyiv, rather than passively

Anti-tank barricades and other defences soon became a part of daily life, but these 'hedgehogs' in central Kyiv underline the extent to which, at the start of the war, there was a genuine fear that Russian forces would take the capital. (Oleksii Chumachenko/SOPA Images/ LightRocket via Getty Images)

awaiting a new, Russian-picked government, began to mobilize to resist. In the first day alone, 18,000 AK-47 rifles were issued to volunteers, while others began to dig trenches, raise barricades and assemble stocks of Molotov cocktails.

In response, the Russians stepped up their air and missile attacks, but also launched an operation to encircle the city from the north and the east. In particular, a massive mechanized force began to advance on the city from the territory of Belarus: perhaps 10,000 troops from at least 10 BTGs, including almost 1,000 tanks. The line between formidable task force and a 40-mile traffic jam, though, proved all too easy to cross. Snowy and muddy conditions forced the Russians to stick to the roads, and with limited co-ordination and co-operation between BTGs, they soon began to get in each other's way. Even without Ukrainian involvement, incompetence, breakdowns and the fact that many of the unprepared forces only had three days of fuel meant that this advance moved forward very slowly before grinding to a halt.

In any case, the Ukrainians absolutely were involved. Bridges along potential routes were blown up, to channel the invaders onto other roads or force them to waste time building new ones. Soldiers of the 80th Air Assault Bde, for example, were camped within the forests of the outer layer of the

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T-90M FIRING MISSILE

The T-90M *Proryv* represented the most advanced Russian tank in service in 2022, and was expected to be able to, in the words of one major of the armoured forces, 'gobble up Ukrainian tanks like snacks'. In fact, the Ukrainians proved more indigestible than anticipated, but nonetheless the T-90M did prove a formidable weapon, especially as its 2A46M5 125mm smoothbore gun could also, as here, fire the 9M119M Refleks ATGM. With semi-automatic command to line of sight (SACLOS) laser beam-riding guidance, the Refleks can hit targets out to more than 3.7 miles, including helicopters as well as ground targets, with a powerful tandem shaped-charge HEAT warhead. This T-90M from the 90th Guards Tank Division, operating during the initial drive towards Kharkiv, has just fired a missile at a Ukrainian T-80U some 3 miles away, which hit, but fortunately for the crew, largely glanced off the glacis. Below is shown a Refleks missile along with the 9Kh949 ejecting mechanism that fires it from the gun, before its own engine ignites.

The Anglo-Swedish NLAW anti-tank missile launcher was one of the early 'stars' of the war, easy to use and supplied in adequate numbers such that they could be distributed widely. It has an effective range of out to 800mm and its 1.8kg warhead can be fired either in direct or top-attack mode. (SERGEI SUPINSKY/AFP via Getty Images)

Chernobyl Exclusion Zone, created by the 1986 nuclear disaster, and they destroyed the bridge connecting Chernobyl with the town of Ivankiv to the south-west. As a result, the Russian BTG dispatched along that axis had to spend an extra day building a replacement pontoon bridge, while the 80th Bde fell back to join the defence of Kyiv.

At the same time, the convoy was harried by drones and ambushes. In the early days, before the Russians adapted, Turkish-built Bayraktar TB2 drones successfully struck self-propelled guns (SPGs), surface-to-air (SAM) missile systems and several tanks with their bombs, supplemented by homemade unmanned aerial vehicles (UAVs) carrying grenades and smaller charges. Arguably even more effective were surprise attacks on columns using anti-tank weapons, including the US FGM-148 Javelin, lighter UK-supplied NLAWS and German Panzerfaust 3, domestic systems such as the Skif (Scythian)/Stuhna-P and RK-3 Korsar (Corsair) laser beam-riding missiles, and even shorter-ranged man-portable RPG-7 and RPG-18 rocket-propelled grenade launchers.

Roman, a lieutenant in a BTG from the 37th Independent Guards Motor Rifle Bde commanding a platoon of T-72B3s, recounted on social media how his unit had rounded a corner on the road north of Demydiv to be met

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KYIV CONVOY UNDER ATTACK BY UKRAINIAN ATGMS

Despite some claims of a bloodbath, in the main the infamous 'Kyiv Convoy' was eventually withdrawn in relatively good order once it became clear that hopes of an easy seizure of Kyiv had been dashed. Nonetheless, there were a series of devastating attacks on the convoy, even as it pulled back. Whereas anti-tank missiles had played a key role in hindering the initial advance, it was again artillery that did the most damage during the withdrawal. Here, a mixed force of T-72B3 tanks and BMP-3 IFVs from the 36th Independent Guards Motor Rifle Brigade withdrawing towards Prybirsk has come under a devasting attack from Ukrainian 152mm artillery, with fire being corrected thanks to the presence of two Bayraktar TB2 drones, one of which is passing above the killing zone.

A Ukrainian T-64BM opens fire with its 125mm KBA3 gun, produced by the Malyshev ZIM plant. (US Army photo by Spc Javon Spence)

with a simple barricade of two parked buses. Despite his own misgivings, on the order of his commander, he sent one of his tanks to shunt the first bus out of the way, when an ambush was sprung. An improvised bomb in one of the buses was detonated, although this failed to do more than rock the lead tank. Then, an ATGM, likely a Stuhna-P, was launched by a team concealed in a nearby building. This blew away three of the tank's right-side roadwheels and broke the treads, essentially immobilizing it. Meanwhile, two RPGs were launched at Roman's own tank. One missed, the other glanced off the angled side of the turret before exploding harmlessly. As Roman grumbled, 'we had no infantry support then, so all we could do is blast away left and right with 125 [main gun] and MGs [machine guns], and hope we scared them away'. The Ukrainian attackers quickly withdrew, apparently taking no losses. With his commander refusing to countenance

Even the most advanced tanks are vulnerable, and here Ukrainian soldiers scavenge an abandoned Russian T-90A in Kyrylivka, near Kharkiv, in September 2022. (YASUYOSHI CHIBA/AFP via Getty Images)

any delay, Roman's team had to abandon the damaged tank and again use their vehicles to bulldoze the burning wreckage of the buses out of the way. They then had to check no serious damage had been done to their vehicles before continuing. This one minor engagement, just one of many, had cost the Russians one modern tank and, above all, an extra hour or two. Even so, they were lucky – as Roman concluded, 'there were a dozen trucks backed up behind us; had the [Ukrainians] had any artillery on call, we would have lost food, ammunition, the lot'.

The initial plan, according to captured Russian schedules, had been that after the first BTG crossed the Ukrainian border at 4.00 am on 24 February, the column was meant to reach Kyiv by 2.55pm the same day. This presupposed neither accidents nor resistance, and was always wholly unrealistic. Even so, a march that should have taken at most three days to reach Kyiv, according to most independent military analysts, was still more than 15 miles away by the beginning of March and apparently stalled. By the end of the month, Moscow had begun pulling this force back – leaving a graveyard of wrecked and abandoned vehicles in its wake – to focus its efforts on the south and east.

The battle of Volnovakha (February/March)

Volnovakha, a strategic city in the contested eastern Donetsk region, is a hub on the rail lines between the regional capital Donetsk and Russia, as well as the lines connecting to Crimea and the port city of Mariupol. Captured briefly by pro-Russian forces in May 2014, it was recaptured in July and remained in government hands until it was taken in March 2022 in a brutal assault by the Russians and forces putatively controlled by the 'Donetsk People's Republic' (DNR), one of Moscow's two proxy regimes in south-eastern Ukraine. Nonetheless, its resistance is considered to have delayed the crucial Russian attack on Mariupol by at least a fortnight, which gave the defenders greater time to prepare for the eventual siege.

On 25 February 2022, the town came under shelling and the next day the DNR's Sparta Bn and 100th Bde attacked the city, where they were met by the government's 53rd Mechanized Bde and the Aidar Assault Bn. The

The forces of Russia's DPR and LNR pseudo-states were, until they rolled into the Russian army when they were formally annexed in September 2022, largely equipped with dated hand-me-downs and vehicles captured from the Ukrainian government. There were exceptions, though, such as this T-72BV. (Photo by Leon Klein/ Anadolu Agency via Getty Images)

A T-72AV of the Ukrainian 10th Mountain 'Edelweiss' Assault Brigade in Donetsk Region. (Khrystyna Lutsyk/Global Images Ukraine via Getty Images)

100th Bde included a tank battalion with a mix of T-64s and T-72s, while the 53rd Bde fielded a battalion of T-64BVs. Tank units from both sides found themselves clashing at the bus station in the centre of the city, not least because it offered more open terrain suited to such an engagement. However, smoke and driving snow quickly reduced visibility, making this more of a tank brawl than a choreographed engagement. The DNR forces were generally poorly trained and equipped with older-version tanks, whereas the 53rd was a seasoned unit and a third of its T-64BVs had been fitted with thermal imaging sights, which gave them a considerable advantage in the murky conditions: 'we could see them, they were blind', summarized one 59th Bde tanker.

At first, the government forces were thus able to hold their own, even as the city was being battered around them, with a number of DNR tanks knocked out or simply abandoned by their crews on being hit, even if their vehicle was still wholly operational. However, over time the numbers of the attackers, and the risk from infantry-fired anti-tank weapons began to force the defenders to retreat. Even more serious was the threat posed by artillery fire, as the DNR forces began plastering the area with 122mm rounds from D-30 guns and 2S1 SPGs, as well as rockets from a battery of BM-21 Grad launchers. The only reinforcements that would be available to the Ukrainian forces were a few volunteer units, while the DNR troops would soon be joined not only by their own Vostok Bn and 3rd Independent Motor Rifle Bde, but also by regulars from the 429th Motor Rifle Rgt of the Russian 19th Motor Rifle Div.

On 28 February, the invaders launched a renewed push, and in contrast with earlier attacks, actually began to practise their combined-arms tactical training, with infantry supporting the tanks, and artillery used to cover advances and shatter Ukrainian attempts to assemble for a counterattack. A real difference was made by the better-trained and -equipped 429th Rgt, not least as it fielded a battalion of T-72B3s that proved much more dangerous than the ageing vehicles of the DNR forces. Fortunately for the defenders, by this stage the battle had largely become a vicious close-quarters struggle in Volnovakha's ruins. The Russians largely used their tanks as fire support 'snipers' from a distance, to avoid their being caught in anti-tank ambushes at close range. This minimized the risks they faced, but also allowed the Ukrainian forces to retreat behind the ample cover provided by the ruined city. Although the defenders were joined by elements of the 503rd Naval Infantry Bn, the 15th Mountain Assault Bn and the 54th Mechanized Bde,

A Ukrainian T-62 which has been immobilized by a Russian Lancet loitering outside the contested city of Bakhmut. (Lynsey Addario via Getty Images)

they were driven out of what was left of the city, opening the way for the Russians to move against Mariupol. The weight of the attacking force, which was joined by a BTG from each of the 810th Guards Naval Infantry Bde and 31st Air Assault Bde, as well as at least two from the 150th Motor Rifle Div, combined with greater air and artillery support, swung the day.

Volnovakha eventually fell on 11 March after a failed Ukrainian counterattack, and with the city in ruins. The Ukrainians lost at least eight T-64BVs, abandoned or destroyed, and one T-72B. General Kyrylo Budanov, head of Ukrainian military intelligence, would later describe this as one of the three major Ukrainian defeats in the war, the other two being the occupation of Crimea in 2014 and the battle of Sievierodonetsk in Luhansk region in May/June 2022, a hard-fought urban engagement more reminiscent of Stalingrad in World War II. One could question this assessment, not least when set against the far more brutal struggle for Mariupol which followed. However, what Volnovakha did demonstrate was the importance of not just training but, in particular, modern optics and fire-control systems in the tank battle – but also how numbers and artillery can override almost any such advantage.

The harrowing of the 4th Guards Tank Division (September)

The 4th Guards Kantemir Tank Div is one of the elite 'palace guard' units, based at Naro-Fominsk just outside Moscow and along with the 2nd Guards Taman Motor Rifle Div is intended as much to deter any risk of a coup from the other armed formations in and around the capital as to undertake combat operations. Indeed, in October 1993 it played a crucial role in the constitutional crisis that led to a stand-off between President Boris Yeltsin and his recalcitrant parliament. Several T-80UDs from the 4th Guards Tank shelled the confusingly named White House – the seat of the Russian parliament at that time – forcing it into surrender. Nonetheless, it was and is also a combat unit and participated in the First and Second Chechen Wars (1994–96, 1999–2009), as well as peacekeeping deployments in South Ossetia (1997) and Kosovo (1998–2002). While briefly downsized as part of wider reforms to the 4th Independent Guards Tank Bde in 2009, it was reconstituted as a division in 2013.

A view of a Russian T-80U from the 4th Tank Brigade that shows clearly the turret's armoured stand-off flaps around it, intended to protect against shaped-charge and tandem rounds, and the mountings for ERA blocks (currently not fitted) on the roof. (Vitaly V. Kuzmin, Creative Commons Attribution-Share Alike 4.0 International Licence)

As part of the 1st Guards Red Banner Tank Army, it played a major role in efforts to capture Ukraine's second city, Kharkiv. In the initial stages of the invasion, the Russians were able to make serious inroads into Kharkiv Region, taking the strategic city of Izium, south-east of Kharkiv, in April. Kharkiv itself came under direct attack by early May, but held, and by summer the front line was stabilizing. However, as Moscow diverted forces in a vain attempt to hold the southern city of Kherson, Kyiv concentrated forces for a counterattack which would prove stunningly successful. On 6 September, they launched a surprise operation that swept through Russian positions which had been stripped of many of their garrisons, and were often held instead by DNR and LNR militias of indifferent quality and *Rosgvardiya* – Russian National Guard – internal security paramilitaries rather than front-line troops. Izium and the strategic town of Kupyansk (east of Kharkiv) were liberated within a week. As newly supplied US HIMARS guided-rocket artillery was used to hit supply bases and troop concentrations behind the lines, the Russians withdrew from most of Kherson Region, to behind the Oskil River. Even so, efforts to organize a new line of defence

The war quickly demonstrated that in an age of advanced fire control systems and accurate long-range guns and missiles, it is better to be concealed than well-protected, hence the generous amounts of camouflage netting on this vehicle from Ukraine's 1st Tank Brigade. (Pierre Crom/Getty Images)

Although direct fire from other tanks, ATGMs, mines and drones all took their toll, artillery pieces like these Ukrainian 122mm 2S1 SPGs remained the real lords of the battlefield. (PULSE NEWS, Creative Commons CC BY)

along the Oskil and Siversky Donets rivers were only partly successful, and the Ukrainians would establish a number of bridgeheads on the eastern banks of both rivers such as to threaten the Russian-held Lugansk Region. By the end of the operation in early October, the Ukrainians had retaken more than 4,500 square miles in the Kharkiv Region

The bulk of the 4th Guards Tank Army had been redeployed to Kherson, but much of the 4th Guards Tank Div remained, in Izium and east towards the Oskil. Most reports say two tank regiments were present, although these may have been augmented BTGs drawn from its 12th and 13th Rgts, respectively, along with support elements from the 137th Reconnaissance Bn and 275th Self-Propelled Artillery Rgt. As they were one of the few regular Russian units in the area, the Ukrainians targeted them as a priority with long-range artillery and accurate HIMARS fire.

These two BTGs were briefly engaged around Izium, but then hurriedly withdrew to avoid being encircled. In the process, they left behind ten T-80BVs. The 4th was, after all, the largest single user of T-80s in the Russian army at the time, and in the first three weeks of the war, according to Ukrainian intelligence sources, had lost 71 of them (65 T-80Us and six T-80BVs) out of a total fleet of 200–217 tanks. As they withdrew, they were hit by the T-72s and T-64s of the Ukrainian 4th Tank Bde, as well as further artillery salvos. According to survivors of the division, the artillery was a particular problem, as the Ukrainians had powerful 152mm 2S3 SPGs in range and – although initially the Russians did not realize this – drones in the air to provide real-time fire correction. Although accounts of a rout were exaggerated, the remnants of the 4th Div were forced to retreat farther, all the way to Borovaya inside the LNR. They left behind another 80 or so T-80s, meaning that since the start of the war they had seen some three-quarters of their initial fleet destroyed or abandoned, and while they had been partially reconstituted in that time, the Ukrainians estimated they had received no more than 50 new T-80s, so these elements of the 4th Div were still at no more than half strength by the time they limped into Borovaya – while at least 20 of their former tanks would be taken into Ukrainian service.

The war would be fought in a range of conditions and environments, and the deep Ukrainian winter offered particular advantages for armoured units when the ground froze hard, but equally serious challenges when the thaw, the so-called *rasputitsa* – literally, the season of bad roads – turned it into thick mud. The Ukrainian T-64BV has assumed a firing position in the southern Donbas as it awaits an anticipated assault by soldiers of Russia's Wagner mercenary army. (Scott Peterson/Getty Images)

REINFORCEMENTS AND REFURBISHMENTS

Not having anticipated hard or protracted fighting, the Russians were not ready for the heavy losses they suffered, including an estimated 1,500 tanks destroyed, seriously damaged or abandoned in 2022 alone. In the scramble to fill the gap, Moscow began to raid reserve stocks of older tanks which had been in storage depots. Dated, and often needing considerable work to make them battleworthy, these did at least represent a source of heavy metal at their disposal. Already by May, T-62s reactivated from a depot in Siberia were arriving in Ukraine, although it would take until the following year for even older T-55s to appear. By the end of the year, though, the Russians had established fairly well-organized programmes not simply to reactivate reserve stocks, but also to give them simple upgrades, including ERA and 1PN96MT-02 analogue thermal gunner's sights. These hardly brought them up to modern standards, but did help make them a little more useful on the battlefield.

Meanwhile, Ukraine was the beneficiary of donations of tanks from NATO member states, largely former Warsaw Pact nations which had

F

PT-91, M-55S, T-72M4 CZ

Although later more-advanced Western designs would be supplied (as well as less-advanced ones such as the 1960s-vintage Leopard 1), the first tanks to be supplied to the Ukrainians were upgraded Soviet-legacy vehicles from Central Europe. From top to bottom, this illustration shows three such tanks: the Polish PT-91 Twardy, the Slovenian M-55S and the Czech T-72M4 CZ. Poland initially provided relatively unmodernized T-72Ms, with the main bulk of their PT-91s, a much more heavily retooled version, arriving in 2023. This example is still in distinctive Polish camouflage and is flying the Polish army pennant during the handover ceremony. Note the Erawa composite armour blocks on hull and turret. Whereas most of these donations were T-72 variants, the M-55S is an upgraded T-55 with its original 100mm gun replaced by a NATO-standard 105mm L7 with a thermal sleeve and additional metal and reactive armour. This unit, now in service with the 47th Mechanized Brigade, has been stencilled with the Ukrainian military cross on its glacis. The T-72M4 CZ is a very well-regarded T-72 upgrade, here shown still in its Czech camouflage even though it is

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Ukrainian 2S1 Gvozdika self-propelled howitzer during the Independence Day parade in Kyiv. (Michael, Creative Commons Attribution 3.0 Unported Licence)

upgraded Soviet vehicles. These were, after all, at once much more familiar to Ukrainian crews and technicians and also, to be blunt, tanks that the donors were happy to dispose of, so that they could re-equip with more modern counterparts more inter-operable with other NATO models. Kyiv received 72 T-72M4 CZs from the Czech Republic (as well as a crowdfunded T-72 Avenger), over a hundred Polish T-72M1s and PT-91 Twardy tanks and 28 M-55Ss from Slovenia.

T-72 variants

While still a unified satellite of Moscow's, Czechoslovakia produced the T-72M to the Soviet design in its ZŤS Martin works, but as the original tanks became increasingly outdated, and given the opportunities to draw on modern Western components, the Czech Republic decided to upgrade a battalion's worth of them. Between 2003 and 2006, VOP CZ, in partnership with Italy's Finmeccanica and Israel's Nimda, upgraded 30 to the new T-72M4 CZ standard. The original 125mm 2A46M main gun was retained, but made much more accurate with the fitting of a Selex Galileo TURMS/T computerized fire-control system. A new Perkins Condor CV 12 powerpack, along with new automatic transmission and a modified chassis makes it more agile, while beyond some reinforcement of the armour, it is also fitted with Dyna ERA and an active protection system that warns the crew and fires smoke grenades when the tank is being painted by a laser rangefinder.

The Czechs were among the first to send tanks to Ukraine. In April 2022, they sent 40 export-grade T-72M1s which had been mothballed, in a deal whereby Berlin then recompensed them with 15 Leopard 2A4 tanks and a Buffel ARV. Next, the Czechs bought more T-72M1s from Bulgaria for Ukraine, and then in October, the first seven of 72 T-72M4 CZs which represented their entire operational fleet of this model. All told, in the first year of war, Prague sent Kyiv 89 tanks, including 'Tomáš the Tank', a unique T-72 'Avenger' crowdfunded by ordinary Czech citizens who raised more than $1.3 million to upgrade it with new optics, fire control, powerpack and armour in a campaign dubbed ironically 'A Gift for Putin'.

Poland was also an early and enthusiastic supporter of Ukraine's, and over the first two years of the war would end up sending its entire fleet of T-72s to the war, clearing its inventory for the 980 South Korean K2 Wilks (Wolf) and 350 American M1A2SEPv3 Abrams tanks it would go on to buy. First, in April, it provided Kyiv with almost 100 T-72M1s that had been built in Poland in Warsaw Pact times by Bumar-Łabędy. It then started sending its upgraded PT-91 Twardy (Obdurate), with most of its total fleet of 230 being transferred to Ukraine's military in 2023. Modernized by Bumar-Łabędy, the PT-91 features an upgraded Wola 850hp diesel powerpack and transmission, Erawa-1 or -2 ERA and new communications and digital fire-control systems.

M-55S

Unlike the Czech and Polish designs, the M-55S is a heavily modernized T-55. All 30 of Slovenia's stock of T-55s were rebuilt in 1997–99 with the co-operation of Israeli company Elbit Systems. Their original 100mm gun was replaced with a version of the British Royal Ordnance L7 105mm rifled gun, a venerable weapon – even if still better than the original – made rather more effective with the introduction of a digital ballistic computer and stabilized fire-control system and a Fotona SGS-55 day/night sight, with laser rangefinder. There was not much that could be done with the tank's rather thin armour, but reactive armour and rubber skirts help provide a degree of extra protection, and with new suspension and a more powerful V-55 V12 diesel engine, it is more nimble. In September 2022, Slovenia announced it would donate all 28 of its working M-55Ss to Ukraine as part of a deal whereby it would receive 35 trucks from Germany in return.

A late-model T-72B on the outskirts of Bakhmut in December 2022. Note the Luna IR searchlight alongside the main gun, as well as the usual recognition cross. (SAMEER AL-DOUMY/AFP via Getty Images)

Captured tanks

The spectacle of abandoned but fully functional Russian armoured vehicles being towed away by Ukrainian farmers' tractors became something of a meme in 2022, following the case in February when an MT-LB tracked transporter, left behind when its fuel ran out, was neatly seized even as a crewman vainly tried to run after it. Subsequently, video footage aired showing two tractors towing away an Osa (SA-8) surface-to-air missile system and in April even a T-72B3 tank. More often, though, vehicles were abandoned when damaged or broken down, and captured by Ukrainian forces and pressed into service – sometimes needing nothing more than a full tank of fuel – or if beyond repair, stripped for spare parts. Considering that both sides' equipment shares the same basic DNA, it was relatively easy for captured vehicles to be used by both sides.

As the Ukrainians launched successful counterattacks, such as the September–October Kharkiv operation, they would seize even more tanks and other equipment left behind by the retreating Russians. Because Izium was a rear-area support base, for example, when it fell, they also acquired such heavy equipment as 152mm Msta-S SPGs and even a T-90M in the unusual Nakidka (Cape) 'stealth' coating, intended to reduce a tank's

MEMETIC WARFARE

Kyiv proved much more imaginative and effective than Moscow in mobilizing genuine footage and images of the war along with humorous caricatures to raise morale at home and win friends abroad. However few the cases of Russian vehicles repossessed by farmers might have been in reality, they spawned a whole cottage industry of such memes, with online images of everything from the Kremlin to Russia's sole aircraft carrier, the *Kuznetsov*, being dragged away behind tractors. In July 2022, the *Ukrposhta* postal service issued two stamps showing Russian tanks under tow. In March, the National Agency for the Protection against Corruption even reassured potential tank-nappers that captured Russian armoured vehicles would not be taxed.

This Russian tank was taken as a trophy by the Ukrainians during the September fighting for Izium. The notation '*Allahu Akhbar*' on the end of the barrel suggests a crew from one of the under-developed Muslim regions of the Russian Federation, which are disproportionately represented in the army because it is an escape from poverty. (Viacheslav Mavrychev/ Suspilne Ukraine/JSC 'UA:PBC'/ Global Images Ukraine via Getty Images)

infrared and radar signatures. The 10th Mountain 'Edelweiss' Assault Brigade, indeed, ended up fielding a number of trophy tanks, mainly T-80s. According to one independent assessment, in 2022 alone, the Ukrainians captured 544 Russian tanks, although by no means all were battleworthy. Nonetheless, this ironically made Russia the Ukrainians' most significant single supplier of armoured vehicles in 2022.

This was a two-way process, though. In particular, the forces of both the DNR and LNR fielded captured Ukrainian tanks, taken in the past eight years of undeclared conflict. These included several dozen T-64s captured in the early stages of the 2014 insurrection, of which around a hundred were in use at the start of the invasion, and T-64BVs taken by the DNR forces when Mariupol fell in May 2022.

Field modifications

All wars are as much struggles of innovation as anything else, and this conflict saw both sides climbing a very rapid learning curve, as they adapted to unexpected threats or old challenges used in new ways. Over time, their responses would take more standardized forms, but through 2022, they were typically ad hoc, often amateurish and sometimes wholly unproductive. Russian vehicles in particular quickly began to sport improvised additional armour in response to the proliferation of advanced Western anti-tank systems such as the Javelin. This often involved little more than bolting, hanging or welding additional armour plates on the hulls, sometimes backed with thick rubber sheets, although this had more value for thinner-skinned armoured personnel carriers (APCs) and the like.

The extensive use of drones also bred its own series of countermeasures. The larger and more conventional systems such as the Turkish Bayraktar TB2, sometimes armed with laser-guided bombs, but otherwise spotting for artillery, were initially effective but proved too large and slow to be especially valuable once the Russians were ready for them. On being detected by radar or direct observation, they could be shot down by ground-based gun or

G

RUSSIAN T-80BV WITH CAGE AND EXTRA ARMOUR, TOP AND SIDE

Quite soon in 2022, Russian tanks began appearing with improvised extra armour, as well as stand-off cages and roofs, intended less in the hope of defeating advanced top-attack ATGMs such as the Javelin so much as lighter kamikaze drones or the grenades, RPG-7 rounds and similar smaller munitions dropped by improvised UAVs. These two T-80BVs from the 5th Independent Guards Tatsin Tank Brigade, engaged in operations near Izium, have been fitted with simple mesh screens over the turrets as well as additional metal and rubber additions to the side skirts – note the placement of ERA blocks between them on the lead tank. These mesh screens did not prove especially effective, and by mid-2023, the brigade's tanks would instead often be seen with tougher slat armour screens, which in some cases extended also to protect the relatively

Reactive armour can make the difference between life and death for a tank and its crew, but is still destructive, not least as it means detonating an explosive charge on the hull. In this case, for example, the shaped-charge warhead of a Russian Lancet loitering munition was largely disrupted, but even so, the blast tore away a track shoulder and destroyed the smoke grenade launchers. (Ukrainian Military Center'Militarnyi', https://mil.in.ua/en/)

missile systems or, increasingly, jammed. According to Lt Gen Andrei Demin, commander of Russia's Air Defence Force, over the first 12 months of the war, more than 100 TB2s were downed. However, the 'kamikaze drone' or loitering munition became one of the key weapons of the war, from the highly effective Russian ZALA Lancet, to jerry-rigged Ukrainian FPV (first-person view) commercial drones able to drop a grenade or other warhead. While their main targets were often less-armoured high-value targets such as artillery, air defence systems and APCs, tanks were also vulnerable, especially when not 'buttoned up' – their hatches closed – or if hit on the engine deck at the rear.

In due course, the Russians would start fitting individual vehicles with their own electronic warfare jammers, but a simpler field expedient was to fit 'roofs' or metal cages (often known as 'cope cages' in the West, but 'barbecues' in Russian slang) onto them, to detonate stand-off warheads and incoming drones prematurely. The results may look inelegant, but could sometimes make the difference between a tank-killing top-attack and a scorching of the paintwork. In due course, especially as the Lancet and Russian-improvised 'kamikaze drones' became increasingly widespread, the Ukrainians would also start fitting 'cope cages' of their own.

SUPPORTING THE TANKS

Of course, tanks need to be supported (even if at times the Russians failed to observe this fundamental principle), with everything from APCs and IFVs to provide infantry support, to ARVs ready to ferry damaged vehicles away from the front line for repair. The first year of the invasion saw the use and combat debuts of a number of distinctive such vehicles on both sides, as well as the renewed use of veteran designs.

H

SUPPORTING VEHICLES: BTR-4E AND 9P149 TANK DESTROYER

Without support, tanks are often lumbering and expensive targets, and both Ukrainian and Russian forces seek to ensure (with varying degrees of success) proper combined arms support for their armoured operations. The Ukrainian BTR-4E (top) has a superficial similarity to the Soviet BTR-70/80 APC, but is a more modern vehicle built to Western standards and design assumptions, with the driver and commander in their own compartment at the front, engine and transmission in the middle, and a troop compartment at the rear. This version is fitted with extra slat armour around the remote-controlled Shturm turret, which is armed with a ZTM-1 30mm autocannon, two R-2 Baryer ATGMs (essentially the same as the Stuhna-P) and a coaxial 7.62mm machine gun. It is serving in the 92nd Mechanized Brigade, whose emblem has been applied to the door. Supporting vehicles may also hunt rather than protect tanks. This Russian 9P149 tank destroyer is firing a 9M120 Ataka (AT-9 Spiral-2) radio-guided ATGM during the battle for Mariupol, which means, given that it bears the V recognition symbol used by Naval Infantry BTGs attacking from Crimea, that it was presumably from the 810th Guards Naval Infantry Brigade. The 9P149 is based

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The BREM-1 armoured recovery vehicle is based on a T-72 chassis and mounts a 12-tonne crane and 25-tonne winch. It is in use by both sides, although increasingly a target of choice, to prevent the enemy from recovering immobilized vehicles, and Ukrainian and Russian soldiers alike complain there simply are not enough of them. (Vitaliy Ragulin)

The Russians, for example, deployed their new KAMAZ-63968 Typhoon-K MRAP personnel carriers, losing several, as well as ageing vehicles such as the venerable BTR-50 APC, a number of which were present in the arsenals of the DNR and LNR forces (sometimes taken from museums). A key weakness that was identified early on was the fleet of armoured recovery vehicles, primarily the BREM-1 on a T-72 chassis and the newer BREM-1M based on the T-90. Soldiers complained that there were not enough of them, and that too many were old and had not been maintained properly, such that it was often impossible to retrieve tanks which would have been easy to repair.

Perhaps most dramatic was their use of armoured trains. In total, 2022 saw the Russian Railway Troops using four: the existing *Baikal* and *Amur* and two more, the *Volga* and the *Yenisei*, which were cobbled together from Ukrainian rolling stock. Largely used for protected rear-area logistics and as command centres, they all have different configurations but are commonly equipped with EW systems, ZU-23-2 twin 23mm AA guns and a signals van, as well as at least one troop wagon with escort infantry. The *Baikal*, for example, was given a second ChME3 locomotive so that it could be expanded to ten wagons, including a flatbed used to carry a BMP-2 IFV, as well as its own drone team and embarked security company with mortars and machine guns. The *Baikal* was deployed to the southern front, being identified near the Ukrainian city of Melitopol in March 2022, as a mobile stronghold.

A number of newer Ukrainian designs also saw combat in 2022. Although the BTR-3U and BTR-4 Butsefal wheeled APCs, KhMBD's take on the Soviet BTR-80, had already seen action, the latter in both Iraq and the Donbas, they would play a significant role in providing protected mobility during the Kharkiv counteroffensive, when speed was often crucial.

LESSONS OF 2022

The first year of war was testimony to the old adage that no plan survives contact with the enemy. Obviously, Putin's dreams of a quick, easy and almost bloodless regime change were especially deluded, but the Ukrainians

T-62 APCS

Before the war, the relative surplus of T-62 chassis in Ukrainian stocks encouraged experimentation with converting them into heavy personnel carriers, such as UMR-64 APC and BMP-64E IFV with remote weapons turrets. These did not enter service, but did provide the basis for improvised one-off designs such as the 'Azovets' heavy APC built by an engineering group belonging to the Azov Bn. Heavily up-armoured (including with *Nizh* ERA blocks), it was fitted with two turrets intended to mount GSh-23 23mm aircraft autocannon or anti-tank missiles, yet it was ultimately abandoned because of problems sourcing appropriate optics and was seized by DNR forces in 2024.

Another vehicle built on a T-72 chassis, Russia's BMPT Terminator is a fire support vehicle armed with two 30mm 2A42 autocannons, four 9M120 Ataka missile launchers, two AG-17D grenade launchers, and a coaxial 7.62mm PKTM machine gun. These examples, spotted in the Lugansk Region, were provisionally identified as serving within the 90th Guards Tank Division. (Ukrainian Ministry of Defence/CC - Attribution 4.0 International Licence)

themselves, for all that they had wargamed scenarios of Russian aggression since 2014, also often found themselves scrambling to respond to circumstances. Ultimately, in this first year in particular, they proved much quicker and more imaginative than the hide-bound Russians. Tanks proved to be at once powerful offensive forces when able to be used as intended, but also often terrifyingly vulnerable in an age of precision-guided ATGMs and constant drone surveillance.

Moscow invaded Ukraine with an estimated 3,417 MBTs, and lost perhaps 1,500 in 2022 alone. Conversely, the defenders, who had closer to 1,000 tanks, lost perhaps 250. Indeed, by the end of the year, about a third of Ukraine's entire fleet of T-64 variants had been destroyed. Both sides would, through the war, continue to revise and redevelop their armoured tactics just as they modified their platforms, but even so one can identify

The driver of a Ukrainian tank during the fighting near Bakhmut in December 2022. Note the distinctive soft padded crew helmet, that dates back to Soviet times. (Narciso Contreras/Anadolu Agency via Getty Images)

A Russian tank commander takes a break atop his T-80BV during the tough fight for Mariupol in April 2022. The white armband was another way in which Russian troops distinguished themselves from their enemies (they also used red, or bands in the black and orange of the ribbon of St George, while Ukrainians used blue, yellow or sometimes green). (Maximilian Clarke/SOPA Images/LightRocket via Getty Images)

six particular lessons which emerged from the armoured battles of 2022.

1. Mass still matters

Just as Russia often had to resort to mass infantry attacks – accepting the inevitable casualties – so too it frequently used its tanks en masse, sometimes in what were almost pre-modern cavalry charge tactics. This was, of course, wasteful of lives and materiel, but not necessarily ineffective for all that. In an age of increasingly 'exquisite' – highly capable but also complex and expensive – systems, in certain circumstances numbers still matter. Indeed, as the Russians in particular were forced to raid their stockpiles of older tanks later in the war, a US army officer working as a liaison in Kyiv was forced ruefully to admit that:

> however many mistakes [he actually used a rather more vivid word than 'mistakes'] the Russians made with their tanks at the outset of the war, they didn't just learn how to use them better, they benefitted from having never lost sight of the fact that an old tank in the right place at the right time is better than not having one there at all. The Soviets left them a legacy of old tanks that may outlast NATO's stocks, in that we have so much fewer to give the Ukrainians.

2. See it, kill it

It has long been a precept of modern war that to be seen by the enemy is to be open to being killed by them, but the importance of advanced optics (notably thermal imaging, allowing good visibility at night and in unclear conditions) and fully stabilized main guns became very clear in Ukraine. Only around a quarter of Russia's tank fleet mounted an advanced gunner's sight (generally, the Sosna-U) with day/night capability, as well as modern fire-control systems. The proportion of Ukraine's admittedly smaller tank fleet with comparable capability was closer to a third. Denys, a retired tanker who rejoined the Ukrainian military in 2022, had served on T-64Bs, which have notionally stabilized fire control; however, being assigned to a modernized T-64BM with thermal imaging and advanced sights was a revelation to him. 'This is actually what stabilization ought to be, actually allowing me to keep a target in my sights when we are on the move. It's a game changer.' During the second battle of Lyman, a successful Ukrainian counterattack in September–October 2022 that saw them retake this embattled city, Denys recounted being able to damage two Russian T-72s at ranges of up to half a mile, while moving at speed, admitting that he would have been hard-pressed to have done that in his old T-64B.

3. Tank fights are often knife fights

Although tank-versus-tank engagements were quite rare, they did happen, but often not in ways that either side had predicted. The emphasis given in

The configuration of the autoloaders used in so many Soviet-legacy tanks means that there is a ring of rounds stored around the turret, ready for use. When detonated by an incoming round, they often explosively pop off the turret. (Dmytro Smolyenko/Ukrinform/Future Publishing via Getty Images)

design and training on long-range 'sniping' by tank gunners often gave way in reality to short-range armoured mêlées such as at Volnovakha, where rapid response, targeting and reloading were crucial. The traditional trade-off inherent in Soviet tank designs, of speed and a low profile in exchange for heavier armour, proved a bad deal in many such close-quarters tank battles. In the advance to the port city of Mariupol, for example, the T-90As of the 150th Motor Rifle Div's 68th Guards Tank Rgt proved very effective at engaging and destroying Ukrainian positions and a number of T-64s deployed to try and slow them down. However, once the battle became a bloody and messy urban fight, their engagements with the defenders' relative handful of T-64 variants saw the honours much more even, as positional advantage, speed and luck proved more important than any notional differences in armour and technology.

4. The drone is unavoidable

The Russian-Ukrainian War has proved to be the first conflict in which the drone – and anti-drone countermeasures – really has proved to be essential in every aspect of the fight. Early claims that the drone made the tank obsolete were premature, as tank-busting systems such as the Bayraktar TB2, for example, took heavy losses once the Russians were alive to the threat they posed and improved both their EW and also AA protocols to address them. By 2023, Col Volodymyr Valiukh of Ukrainian military intelligence was admitting that 'I don't want to use the word useless, but it is hard to find situations where to use [TB2s].' Although drones would continue to have an anti-tank role using bombs and missiles, the proliferation of small reconnaissance systems, notably commercial FPV quadcopters, would

Although they lagged behind the Ukrainians in the breadth and scale of their use, especially in the first year of the war, the Russians also supported their forces with drones, such as this Orlan-10 reconnaissance UAV. (Andrey Rusov/RMOD)

A mechanic works on a damaged tank at a Ukrainian repair warehouse. (Viktor Fridshon/Global Images Ukraine via Getty Images)

mean that the battlefield was under constant surveillance. Any concentration of forces could be identified well in advance of an attack, and any high-value target – including advanced tanks – spotted for artillery. Artillery remains, after all, the main threat to tanks as much as to every other asset on the battlefield. When the Russian 6th Tank Regiment advanced into the town of Brovary in March 2022 during the attack on Kyiv, for example, it first hit a minefield and then its first and last vehicles were hit by ATGMs (probably Stuhna-Ps). The real damage was done when the temporarily immobilized column was then plastered with 122mm rounds from the 2S1 SPGs of the 72nd Mechanized Bde. While combat drones and loitering munitions would become staples of the war, it was this ability for both sides to have a great awareness of the battlefield that would be one of the most pervasive changes, and meant that tanks had increasingly to be protected by EW and other counter-drone measures just as much as physical armour.

5. Survivability and recovery count

Once Western vehicles with their different design philosophies started to enter Ukraine's arsenal in 2023, this would become even more obvious, but even before then, it was very clear that a crucial advantage would go not only to whichever side's tanks were less vulnerable to enemy fire, but which were more able to be salvaged and repaired. According to data from the Dutch open-source defence analysis group Oryx, a penetrating hit on a Russian/Soviet tank, for example, was eight times more likely to destroy it rather than leave it just damaged, a far higher ratio than would be considered acceptable in NATO forces. Even so, there were many immobilized or otherwise damaged tanks. The very trajectory of the war in 2022, with rapid Russian advances, often followed by equally rapid withdrawal, especially along the Kyiv and Kharkiv axes, ensured that the Ukrainians would have ample opportunities not only to recover and repair their own damaged tanks (only about half their losses in 2022 were permanent), but also to capture and salvage abandoned Russian ones. This was magnified, though, by the Russians' lack of emphasis on recovery. Not only did advancing units often

The doughty T-34 was originally developed in Soviet Ukraine, and here one has been used as a Great Patriotic War memorial at Trostyanets in the Sumy Region. The tank has come on a long way since then – and will continue to evolve. (Alexey Furman/Getty Images)

lack ARVs, or even the capacity to call in repair teams from elsewhere, but the unrealistic demands being put on them by the political leadership for rapid advances meant that they often had to abandon easily repairable tanks and other equipment. This would change over time, but given that the BTGs deployed in 2022 were generally those equipped with the best Russian tanks, it did mean a disproportionate wastage of more modern designs, which would often have to be replaced with older, reconditioned models. As Roman, the lieutenant ambushed on the road to Kyiv, recounted, 'my platoon lost a T-72B3. We only got a replacement in 2023, and it was a 40-year-old T-72A with transmission that was already on its last legs.' The Russian war machine was by no means beaten, but just as Ukraine would start to receive modern Western tanks, it was already issuing hand-me-downs.

6. The tank is not dead yet

As usual, the sight of twisted wreckage prompted claims that in the age of the drone and the top-attack missile (which flies above a vehicle and then fires its warhead downwards into its more vulnerable top armour), the tank is obsolete. Yet it is far too soon to write it off. First of all, losses are inevitable in war, and casualties have yet to convince anyone the infantryman is no longer useful on the battlefield, after all. Second, many of the losses reflected poor Russian tactics and practices. Tanks were deployed in open terrain and without proper infantry cover, or were abandoned when they broke down or ran out of fuel and subsequently destroyed if the Ukrainians could not salvage them. Training (or the lack of it) also played a role; while many Russian tanks were fitted with ERA, at least some crews were clearly not properly trained in fitting and maintaining the explosive blocks, meaning that they were badly fitted and thus less effective, or not fitted at all. Both sides took heavy losses to their tank fleets in 2022, but showed no inclination to abandon them. The tank is undoubtedly adapting, whether acquiring heavier armour, EW jammers or 'cope cages', but it has been ever since the first tracked boxes appeared on the muddy battlefields of World War I. It isn't going to be retiring quite yet.

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AUTHOR'S NOTE

Translating out of Cyrillic always poses challenges. I have generally chosen to transliterate words as they are pronounced (so, for example, *Bronetransporter* is rendered as *Bronetransportyor*). I have also ignored the diacritical 'soft' and 'hard' signs found in the original.

GLOSSARY OF ACRONYMS

AA	Anti-Air
APC	Armoured Personnel Carrier
ARV	Armoured Recovery Vehicle
ATGM	Anti-Tank Guided Missile
ATV	All-Terrain Vehicle
Bde	Brigade
BMD	*Boyevaya Mashina Desanta*, Airborne Combat Vehicle
BMP	*Boyevaya Mashina Pyekhoty*, Infantry Combat Vehicle
BMPT	*Boyevaya Mashina Podderzhki Tankov*, Tank Support Combat Vehicle
Bn	Battalion
BREM	*Bronirovannaya Remonto-Evakuatsionnaya Mashina*, Armoured Repair-Recovery Vehicle
BTG	*Batalyonnaya Takticheskaya Gruppa*, Battalion Tactical Group
BTR	*Bronetransportyor*, Armoured Transporter
Coy	Company
Div	Division
DNR	*Donetskaya Narodnaya Respublika*, Donetsk People's Republic
ERA	Explosive Reactive Armour
EW	Electric Warfare
GDP	Gross Domestic Product
IFV	Infantry Fighting Vehicle
KhBTZ	*Kharkivskiy Bronetankovy Zavod*, Kharkiv Tank-Building Factory
KhMBD	*Kharkivskiye Konstruktorskye Byuro z Mashinobyduvannya imeni O. O. Morozova*, Kharkiv Machine-Building Construction Bureau named for O. O. Morozov
LBTZ	*Lvivskii Bronetankovy Zavod*, Lviv Tank-Building Factory
LMV	Light Multi-role Vehicle
LNR	*Luganskaya Narodnaya Respublika*, Lugansk People's Republic
MBT	Main Battle Tank
MRAP	Mine-Resistant Ambush Protected
MT-LB	*Mnogotselevoy Tyagach – Legky Bronirovanny*, Multi-purpose Light Armoured Towing Vehicle
Rgt	Regiment
RPG	*Reaktivny Protivotankovy Granatomat*, Rocket-Propelled Anti-tank Grenade Launcher
SAM	Surface-to-Air Missile
SPG	Self-Propelled Gun
TV	*Tankovi Viyska*, Armoured Troops (of Ukraine)
UAV	Unmanned Aerial Vehicle
ZIM	*Zavod imeni V. O. Malysheva*, the factory named for V. O. Malyshev